Performance Report -- UVI Online Search Tool (UVI-OST)

Title of Grant:	A Climatological Database of Auroral Images for Solar Cycle 23: An Online Synoptic Search and Metadata Visualization Tool
Type of Report:	Annual Performance Report
Principal Investigator:	G. A. Germany
Period Covered:	5/1/2003 - 4/30/2005
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Summary of research objectives and plan

The primary goal of the funded work is to provide an online search and visualization tool of auroral and geophysical metadata covering the ascending phase of the current solar cycle (23). Prior to this program, there were no tools available for searches of auroral features or for visualization of derived parameters such as boundaries, energy input, or presence of given auroral morphologies. The lack of such tools meant that the vast majority of current research using auroral images is event-driven, where the only search criteria is the time of the event. The logistical difficulties of organizing synoptic studies spanning extended times, or of finding particular auroral morphologies regardless of the time of their occurrence, is one of the primary impediments for performing non-event-driven auroral studies.

Most important results during report period

1. Completed development of image miners.

2. Created data server to enable user downloads of digital image data.

3. Continued synoptic auroral investigations.

General summary of performance

Image miners. After considering multiple possible image metadata sets, we settled on three searchable parameters: total auroral energy deposition, fraction of oval within the UVI field of view, and an overall measure of image quality. Auroral energy is directly proportional to the image intensity and can be used to screen out low intensity images for which the image miners may be less than successful. Equally important, auroral energy deposition is a fundamental physical quantity and is used as a proxy of general magnetic activity.

The auroral energy, however, is only derived from that portion of the oval which is viewed by UVI. In cases where the imager views only a portion of the oval the energy parameter will underestimate the total energy deposition. Furthermore, many investigations require a knowledge of the full oval, or at least the full polar cap. This was therefore deemed a critical search parameter.

The final image-derived searchable parameter is the overall image quality. Images with low quality may be low intensity, low contrast images. Alternatively, they may have large noise levels or have significant image anomalies due to telemetry transmission failures from the spacecraft. All our image miner algorithms have higher failure rates for low-quality images and it is therefore critical to identify these potential problems. Therefore we expended a great deal of effort trying to develop an automated measure of image quality. The problem, however, proved to surprisingly difficult. No single algorithm was applicable across our full data set. We explored some more advanced automated image quality metrics, but were unable to fully develop these techniques. We finally augmented our automated techniques with manual inspection of images to develop an acceptable quality measure.

Data server. The original project design considered OST as a search tool only. The output would be a list of UVI time stamps that matched the search criteria. The user was then expected to contact a UVI team member directly to receive the data. This design choice reflected initial concerns about our capabilities and UVI data policy at the time. During the course of the project it became clear that we could easily overcome any technicalities in delivering data to the user. After consulting with the UVI Principal Investigator, it was decided to create a data server whereby the output from the user search could be used to create a custom data set of UVI images that could then be downloaded by the user. A basic software toolkit and viewer was also created

Synoptic studies. One of the profound realizations from this project was the knowledge that the collected search database represented a potentially useful source for synoptic studies of auroral morphology and high-latitude energy input into Earth's upper atmosphere. We presented a series of papers featuring multi-year analysis of auroral activity and exploring the utility image-based activity metrics. These papers, in turn, lead to several fruitful scientific collaborations. This was particularly gratifying in that this was the entire rationale for this project, namely that the need for a tool to enable multi-year synoptic studies.

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